Flo-tech
Hydraulic Diagnostic Products

Turbine Flow Meter

MC4000 Handheld Hydraulic System Analyzer

Badger Meter

TST-UM-00017-EN-03 (February 2015)

User Manual

CONTENTS

PRODUCT UNPACKING AND INSPECTION

Upon receipt of the product, perform the following unpacking and inspection procedures.

NOTE: If damage to the shipping container is evident upon receipt, request the carrier to be present when the product is unpacked.

1. Carefully open the shipping package, follow any instructions that may be marked on the exterior. Remove all cushioning material surrounding the product and carefully lift the product from the package.
2. Save the package and all packing material for possible use in reshipment or storage.
3. Visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

INTRODUCTION

The MC4000 has inputs for two pressure sensors, one temperature sensor, one flow sensor, and one active pickup for RPM measurements. The MC4000 allows simultaneous connection of four sensors with the measurements displayed in four individual LCD windows using preselected process units according to US or DIN norms. The display supports English and one of the following languages selected at the time of order: Spanish, German, Italian, or French.

An internal rechargeable battery powers the MC4000. A green LED indicates a completely charged battery. A fully charged battery permits four hours of operation with two pressure sensors connected. With the charger connected, the battery charges while also allowing use of the instrument. An optional automobile style power cable is available for operation from a car battery.

When in *Datalogger* mode, the MC4000 stores data in an internal 2.5 MB memory space. Each stored measurement contains the day and date from the instruments real time clock.

The MC4CON software utility transfers stored measurements via a USB data port to a Windows PC. The MC4CON program permits bi-directional communication not only for uploading recorded data to a PC, but also for downloading commands from the PC to the MC4000.

All parameters can also be set using the buttons on the instrument's front panel. Pressure units are programmed in psi or bar. The flow and rpm measurements are scaled using programmable constants. Additionally, three point flow calibration for the turbine sensors is available. When activated, the pressure tare function allows offset adjustments and the sets the display to zero at non-zero pressure inputs.

Hydraulic horsepower is automatically calculated from the measured pressure and flow. Horsepower displays as either HP or kW depending on the selected units.

Operating Principle

Fluid entering the meter passes through the inlet flow straightener, which reduces its turbulent flow pattern and improves the fluid's velocity profile. Fluid then passes through the turbine, causing it to rotate at a speed proportional to the fluid velocity. As each turbine blade passes through the magnetic field, the blade generates an AC voltage pulse in the pickup coil at the base of the magnetic pickup (see *Figure 1*). These pulses produce an output frequency proportional to the volumetric flow through the meter. The output frequency represents flow rate and/or totalization of fluid passing through the turbine flow meter. For a complete component orientation, see *Figure 2*.

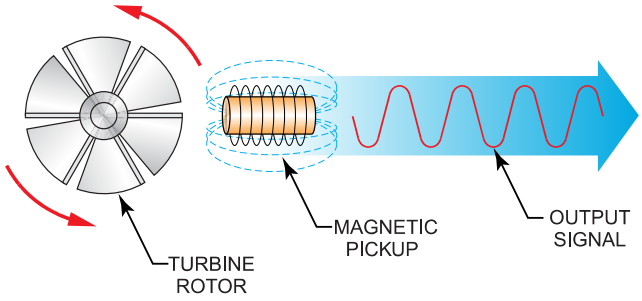


Figure 1: Schematic illustration of electric signal generated by rotor movement

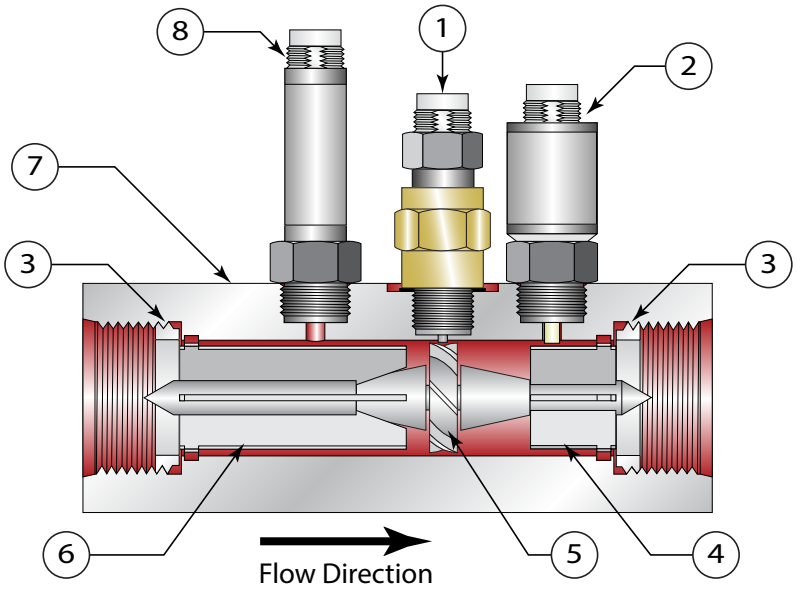


Figure 2: Typical cross section of sensor array

1	Magnetic pickup
2	Temperature sensor
3	Retaining ring
4	Downstream rotor
5	Turbine rotor
6	Upstream rotor
7	Meter body
8	Pressure sensor

CONNECTIONS

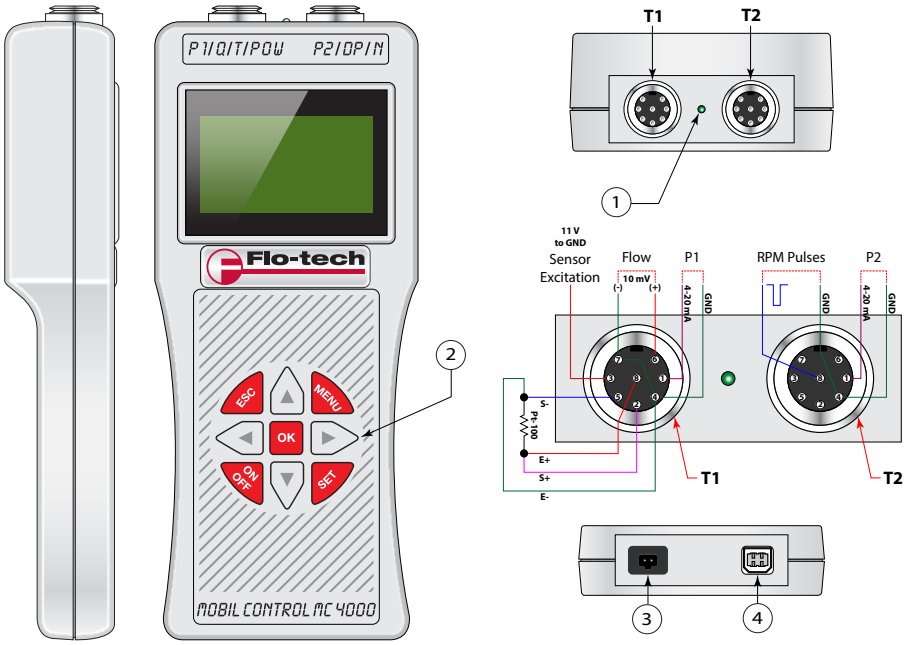


Figure 3: MC4000 controls and connections

1	Battery charging indicator
T1	Flow, pressure and temperature sensors
T2	Auxiliary pressure sensor
2	Keypad
3	Battery charging
4	USB–B port

Table 1: Controls and connections locations

INSTALLATION

Check the interior of the meter for foreign material. Make sure the turbine rotor spins freely prior to installation. Additionally, check and clear fluid lines of all debris.

OPERATION

Measuring Mode

NOTE: Any reference to the P2 pressure sensor assumes installation of the optional pressure sensor in the system.

Start the MC4000 by pressing **ON OFF**. The MC4000 performs a self-test and displays the version number of the firmware and the unit's serial number. Additionally the setup parameters, the battery capacity, date, time ,and free memory are also available. After the startup routine, the instrument automatically goes into measuring mode.

Four windows divide the screen. The two left windows show pressure measurements. The right upper window measures the temperature and the right lower window shows flow or the rpm. Menu commands select the flow (Q) or the rpm (N). Three dashes in a window indicates the absence of a sensor. A battery symbol in the lower right display corner indicates the battery capacity.

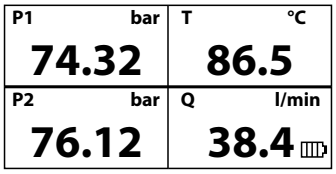
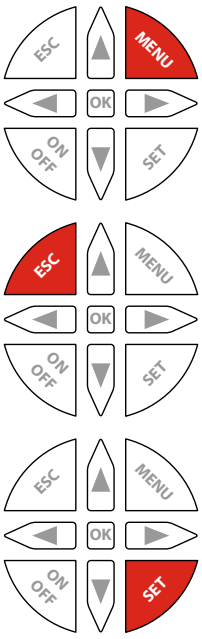


Figure 4: Display in measuring mode

Function buttons MENU, ESC and SET

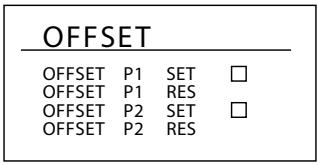


- Access menu commands.
- Scroll through menu options, press and hold to automatically scroll through menu options at one second intervals.

- Backwards menu steps.
- Press three times to switch to measuring mode.

- Activate tare in both P1 and P2 pressure channels

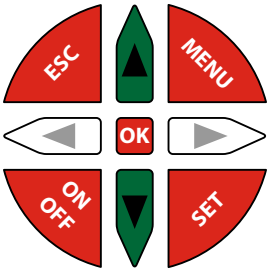
OFFSET	P1	SET	Set pressure P1 to zero – Tare P1
OFFSET	P1	RES	Cancel the tare function – No Tare P1
OFFSET	P2	SET	Set pressure P2 to zero – Tare P2
OFFSET	P2	RES	Cancel the tare function – No Tare P2

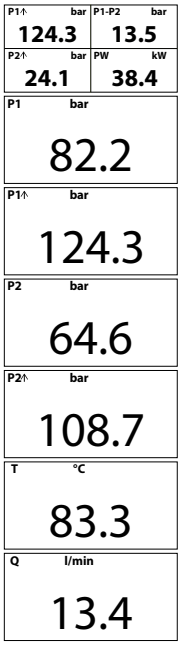


Up and Down Arrow Buttons

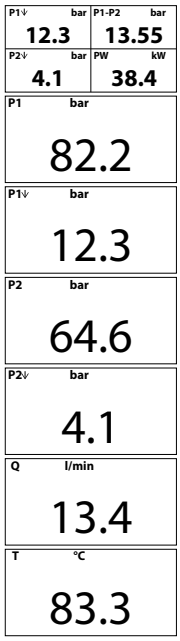
Press **UP** or **DOWN** to view any of following display modes:

- Peak & valley, pressure difference, power
- Large display mode for pressure P1 or P2
- Large display mode for temperature
- Large display mode for flow and rpm





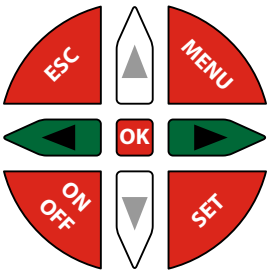
Large display modes display in this sequence by pressing **UP**.



Large display modes display in this sequence by pressing **DOWN**.

Left and Right Arrow Buttons

- Pressing **LEFT** resets the peak & valley memory.
- Pressing **RIGHT** returns to measuring mode.



Programming Menu

Press **MENU** to open the programming menu. Continue to press **MENU** to scroll through the user settings and measurement parameters on the display. Press **UP** or **DOWN** to scroll through the options available for each parameter. Press **OK** to store any new settings, the display will read *DATA STORED*. Press **ESC** to scroll backwards through the menu choices. Press **ESC** three times to return to measuring mode.

Datalogger

The datalogger parameter allows you to start, stop or delete recorded measurement sessions.

DATALOGGER STORE OFF	This command stops recording the datalogging information to memory. Press **OK** to stop an active datalogging session. The screen will display *DATA STORED*.
DATALOGGER STORE ON	This command starts recording data at a selected interval rate, see *"Save Interval"* below. Each record automatically adds the date and time from an internal real time clock. To start a new datalogging session press **OK**. The screen will display *DATA STORED*.
DATALOGGER STORE DELETE	This command deletes all stored data. To delete data press **OK**, the unit will display *ERASE DATA?* Press **OK** again to confirm the request. The screen will display *DATA ERASED*.

The internal memory can save all displayed measurements and permits 224 individual records at a total capacity of 2.5 MB. To start a new datalogging session, press **OK** at the *STORE ON* prompt. After starting a new datalogging session, press **ESC** to switch the display to measuring mode. In measuring mode, an *M* icon indicates an active datalogging session, see *Figure 5*. Stored datalogging sessions can be uploaded to a computer, using the USB data port, for further processing.

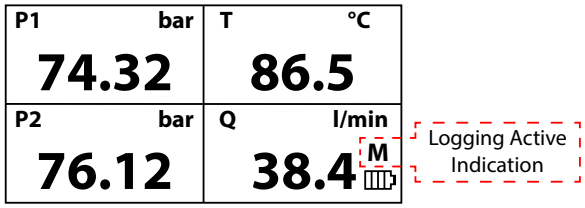


Figure 5: Active datalogging session display

Save Interval

The save interval is the time between two consecutive recording cycles set in fixed increments as shown below.

	Selection	Function
SAVE INTERVAL 1 s	*1s, 2s, 5s, 15s, 30s, 60s, 120s, 300s, 600s, 1200s, 1800s, 2700s, 3600s, 7200s*	This command sets the time, in seconds, between two recording cycles. Press **UP** or **DOWN** to scroll through each interval, when the correct interval is displayed, press **OK** to select the interval. The screen will display *DATA STORED*.

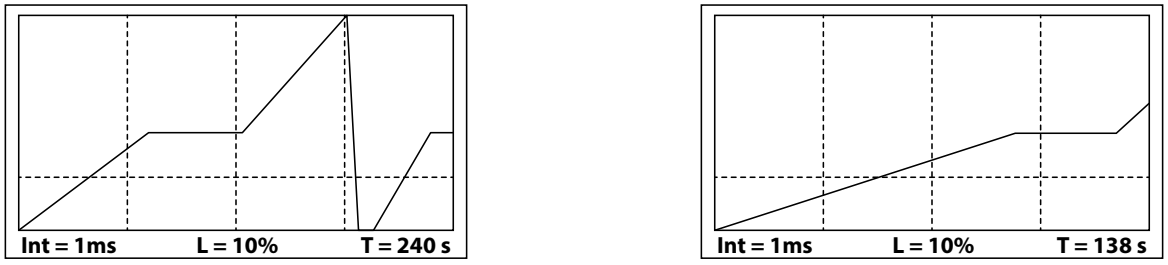
Fast Transients

In the transient menu, you have the option to delete, start, or show a transient. There are two memory locations available to record transients, *TRANSIENT NO.1* and *TRANSIENT NO.2*. Before a new transient can be started, one must be deleted from the memory by pressing **OK** at the *TRANSIENT DELETE* prompt. Each transient contains a maximum 240,000 samples. For example, with a sampling rate of 1 ms the memory capacity is 240 seconds in each memory location. Press **OK** to begin recording, the minimum recording time is 30 s. To stop recording, press and hold **OK** for at least five seconds, D*ATA STORED* is automatically displayed.

TRANSIENTS NO. 1 DELETE	Recorded data, in the transient 1 memory location, is deleted by pressing **OK** at the *TRANSIENT NO. 1 DELETE* prompt. The unit will display *ERASE DATA?* Press **OK** again to confirm the request. The screen will display *DATA ERASED*.
TRANSIENTS NO. 1 START	Data recording, in the Transient 1 memory location, is started by pressing **OK** at the *TRANSIENT NO. 1 START* prompt. The screen will display *TRANSIENT STORED* until the storage session is stopped. To stop the transient, press and hold **OK** after the minimum recording time of 30 seconds. The display will show a graph of the data. This prompt will not display if a transient is currently stored on the device at that location.
TRANSIENTS NO. 1 SHOW	A graph of the transient 1 data is displayed by pressing **OK** at the *TRANSIENT NO. 1 SHOW* prompt, see *Figure 6*. This prompt will not display if there is not a transient stored on the device at that location.

NOTE: The controls for transient 2 work the same way as the controls for transient 1.

The *SHOW* selection displays the stored measurements as graphs. The X-axis shows the elapsed recorded time, the Y-axis shows 0…100% of the full scale pressure set in the pressure channel P1 parameter setup. See *"Scaling for Pressure Sensors" on page 11*. Any recording may be stopped by pressing **OK** before reaching the end of the 240 second maximum record length.



Record using the full memory capacity. Record terminated after 138 seconds.

Figure 6: Graphical pressure representations

Press **ESC** to return the display to the transients menu.

Threshold

The threshold function defines the level at which pressure recordings begin. For example, if the *THRESHOLD SIGNAL* is set to >20%, the pressure recording will not begin until the pressure exceeds 20% of the maximum pressure set for that sensor. The threshold is set using a percentage of the maximum value used to scale 20 mA input in the *SCALE P1* or *SCALE P2* menu item. With threshold set for example at >10% the recording starts when the pressure transducer is sending 5.6 mA of current to the MC4000 display. If scaled for 200 psi, pressure sensor P1 begins recording as soon as the pressure reaches 20 psi.

THRESHOLD SIGNAL <10 %

Selection	Function
>10%, <10%…>90%, <90% in steps of 10%	The recording starts as soon as the input signal exceeds the selected level. Scroll through the options using **UP** and **DOWN**, when the needed threshold is reached, press **OK**. The screen will display *DATA STORED*. For records that have to begin at zero signal level, use <10%.

At the end of a recording cycle, the display automatically shows the graphs corresponding to the stored data from the P1 pressure transducer.

Backlight

BACKLIGHT LIGHT OFF

Selection	Function
BACKLIGHT OFF	The backlight is off.
BACKLIGHT ON	The display illuminates for 30 seconds each time any of the buttons are pressed. Press **OK** at this prompt to turn the backlight on. The backlight set to on reduces battery life.

Date and Time

DATE AND TIME
21:32:45 AM
29/03/13

Selection	Function
HH : MM : SS *DD : MM : YY*	This command sets the internal clock with the time and date. In this prompt, the number that is selected for change will blink. To increase the number press **UP**, to decrease the number press **DOWN**. Once you have reached the appropriate number, press **RIGHT** to move to the next number that needs to be changed. When you are finished press **OK**. The screen will display *DATA STORED*.

Scaling for Pressure Sensors

SCALE P1
+ 100.000

SCALE P2
+ 2.00000

Selection	Function
+000.000…+999.999	This parameter sets the full-scale reading at the point the pressure sensor P1 and P2 has an output of 20 mA. In this prompt, the number that is selected for change will blink. To increase the number press **UP**, to decrease the number press **DOWN**. Once you have reached the appropriate number, press **RIGHT** to move to the next number that needs to be changed. When you are finished press **OK**. The screen will display *DATA STORED*.
+0.00000…+9.99999	

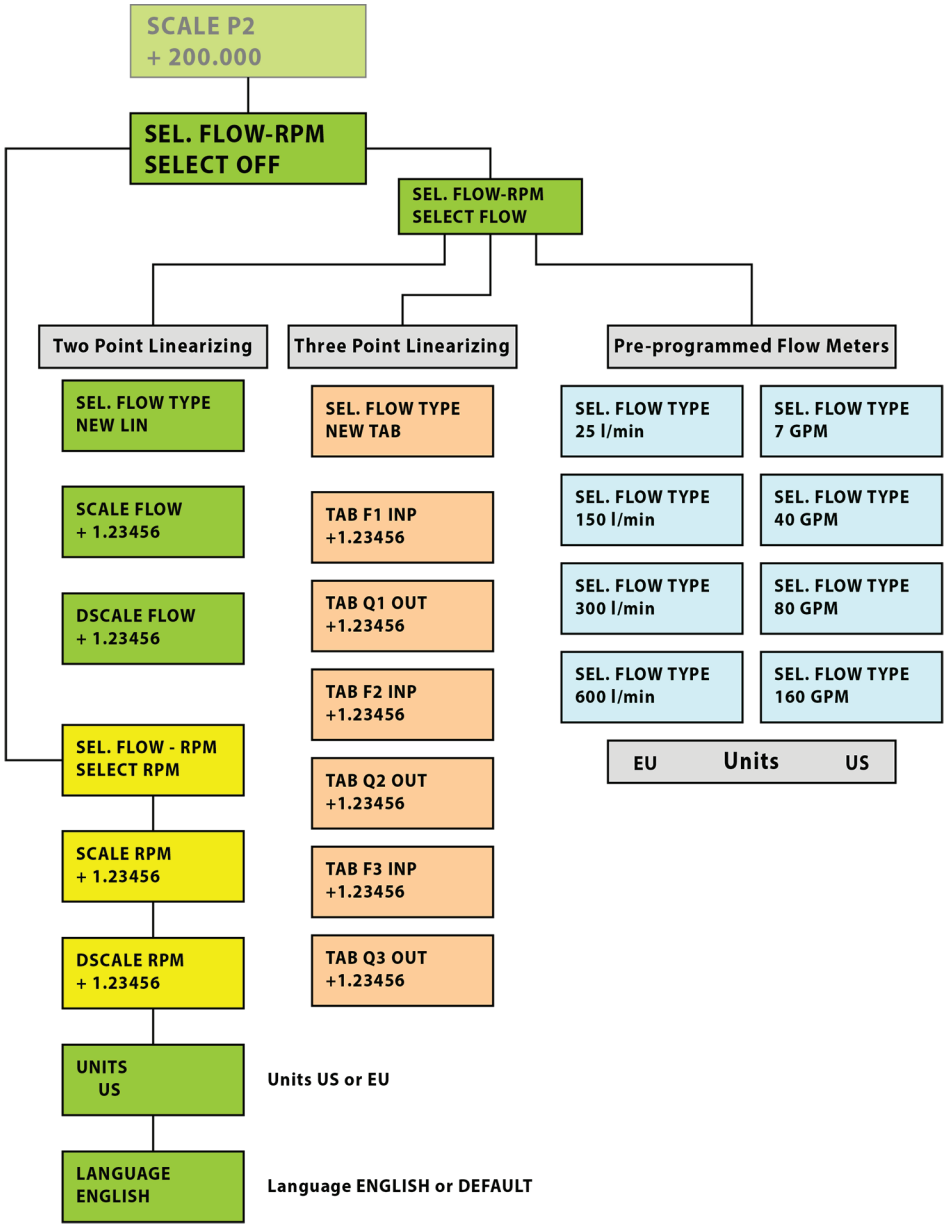


Figure 7: Programming menu map

To exit the programming menu and return to measuring mode, press **ESC** three times.

SUPPLEMENTARY MEASUREMENTS

Peak and Valley

While the MC4000 is in operation, the maximum and minimum pressure measurements from both pressure transducers, P1 and P2, record automatically. Pressing **UP** or **DOWN** displays the measurements.

In measuring mode press **UP** to display the maximum values recorded by pressure sensors P1 and P2. The small arrows on the display points up, indicating displayed readings are the maximums (see *Figure 8*). Press **DOWN** to display the minimum values of P1 and P2. The small arrow on the display points down, indicating displayed readings are the minimums (see *Figure 8*).

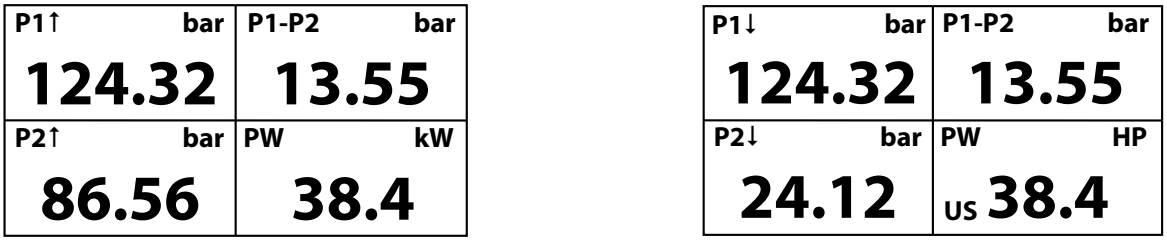


Figure 8: Pressure display screens

Pressure Difference

The upper right quadrant of the display shows the pressure difference between pressure transducer P1 and P2. Stored maximum and minimum readings show in the left side quadrants of the display (see *Figure 8)*.

Power

The lower right quadrant shows the instantaneous power reading in either HP or kW. See *Figure 8.* The pressure units are either psi or bar, temperature readings are in either ° F or ° C.

It is important that the pressure entries and scaling use consistent units of psi and ° F for US measurements or bar and ° C for EU measurements. Unpredictable results occur if the pressure and temperature units are mismatched.

Power Calculations

The power calculation

$$\text{Power (HP)} = \frac{\text{Pressure (psi)} \times \text{Flow (gpm)}}{1720}$$

$$\text{Power (kW)} = \frac{\text{Pressure (bar)} \times \text{Flow (lpm)}}{600}$$

Examples

US–When programmed in US units of pressure (psi) and flow (gpm), the power is calculated in HP.

Pressure = 1450.4 psi
Flow = 52.84 gpm

$$\text{Power (HP)} = \frac{1450.4\ (\text{psi}) \times 52.84\ (\text{gpm})}{1720} = 44.56\ \text{HP}$$

DIN–When programmed in DIN units of pressure (bar) and flow(lpm), the power is calculated in kW.

Pressure = 100 bar
Flow = 200 lpm

$$\text{Power (kW)} = \frac{100\ (\text{bar}) \times 200\ (\text{lpm})}{600} = 33.33\ \text{kW}$$

Two Point Flow Sensor Calibration Using the New Lin Function

The MC4000 menu contains two scaling parameters; *SCALE* and a scaling divisor referred to as the *DSCALE*. The MC4000 flow sensor output signal is a frequency that is proportional to the rate of flow and the monitor uses the frequency information to calculate volumetric flow rate and total flow. The raw frequency from the turbine flow sensor requires scaling by a constant in order to achieve a display reading in the required flow units. The MC4000 refers to this constant as the *SCALE* defined as follows.

$$\text{SCALE} = \frac{\text{Maximum Flow Rate}}{\text{Maximum Frequency}}$$

The *DSCALE* setting is used to shift the decimal point, and is particularly useful when the *SCALE* parameter is a very small number in the case of small, high frequency turbine flow sensors.

Calculated flow readings in the MC4000 use the following formula.

$$\text{Display Reading} = \frac{\text{Input Frequency x SCALE}}{\text{DSCALE}}$$

Example

A typical 1 in. turbine flow sensor would have the following characteristics.

Maximum Flow = 80 gpm
Maximum Frequency = 765 Hz

The scale factor calculation is:

$$\text{SCALE} = \frac{80 \text{ gallons}}{765 \text{ Hz}} = 0.1046$$

The value for this sensor entered into the *SCALE* parameter would be 0.1046. In this case a *DSCALE* value of 1.000 would give correct readings on the MC4000 display.

Using a larger value for *DSCALE* offers higher resolution and is especially useful when the *SCALE* value has several leading zeroes in it.

Example

A small turbine flow sensor has the following full scale values.

Maximum Flow = 7 gpm
Maximum Frequency = 2632 Hz

$$\text{SCALE} = \frac{7 \text{ gallons}}{2632 \text{ Hz}} = 0.0026596$$

Because of display limitations, better results are obtained by multiplying the *SCALE* value by 1000 and using a *DSCALE* value of 1000.

Three Point Flow Sensors Linearizing Using the New Tab Function

Linearization achieves better accuracy of the flow sensor connected to the MC4000. The MC4000 is capable of using up to three linearization points. The points are entered in pairs of frequency values with their associated flow rates. The linear point pairs can be entered using the MC4000 keyboard or from a connected PC.

Linearization Point	Frequency (Hz)	Flow Rate (Q)
1	Frequency F1	Flow Rate Q1
2	Frequency F2	Flow Rate Q2
3	Frequency F3	Flow Rate Q2

The linearization menu makes the assignment of both the frequencies and display readings.

Example

Linearization Pair Number	Frequency Values	Flow Values
Linearization Pair 1	0 Hz	0 lpm
Linearization Pair 2	166 Hz	66 lpm
Linearization Pair 3	630 Hz	150 lpm

MC4CON SOFTWARE

Installation

The MC4000 datalogger connects to a PC by means of a standard USB-A to USB-B cable. The installation requires about 8MB of disk space under Windows.

After inserting the CD into the PC's DVD/CD drive, the MC4CON.exe setup utility opens automatically and installs the MC4CON software on the PC. If the MC4CON.exe setup utility does not start, navigate to the DVD/CD drive and open one of the setup files as shown in *Figure 9*, and then double click on the setup.exe file to start the installation

Figure 9: Setup folders and setup icon

Communication

MC4CON software allows bi-directional communication between a PC and the MC4000 datalogging utility. Communications between the MC4000 and a PC is via the USB port that runs at 230,400 baud. The datalogger function is fully programmable from a PC using the MC4000 in download mode. In upload mode, the PC transfers all recorded data, transients and parameters to the MC4000 for manipulation.

The program automatically searches for an available communications port. When the MC4000 software finds an open port and establishes communications with MC4000, the *Connection* indicator turns green, see *Figure 10 on page 16*. Disconnecting and then re-connecting the USB cable during communication severs the communication link between the PC and the MC4000. To re-establish communications, select *Find COM*. The communication will automatically be re-established.

COM Port Set Controls

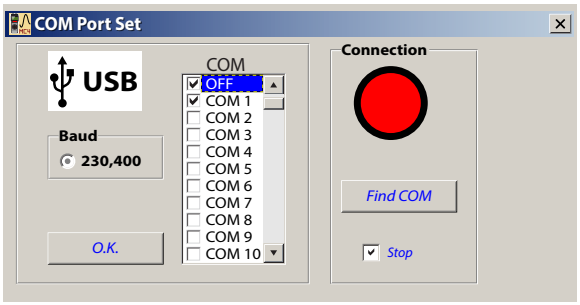


Figure 10: COM port controls

Button	Function
Find COM	Re-establish the communication when interrupted as experienced due to a disconnected cable.
OK	Starts the search for an open COM port.
Stop	Stop searching for an open COM port.
Connection	Turns green when communications are established between the MC4CON software and an MC4000 MC4000 Handheld Hydraulic System Analyzer.

Menu Structure

Exit

Exit	Exits MC4CON software utility

File

Open Data Table	Opens a text file with the file format *filename*.TX2 containing stored datalogger data
Save Data Table	Stores datalogger data to a text file with the file format *filename*.TX2
Open Transient Table	Opens a text file with the file format *filename*.TX1 containing stored transient data
Save Transient Table	Stores transient data to a text file with the file format *filename*.TX1
File Read	Reads setup data stored in a file with the file format *filename*.set
File Save	Stores setup data in a file with the file format *filename*.set
Exit	Exits MC4CON software utility

COM

Select COM	Opens the COM port selection utility

Select

Measurement	Same as selecting *Measurement* on the MC4000 instrument
Menu MC4000	Same as pressing **MENU** on the MC4000 instrument
Datalogger	Same as selecting *Datalogger* on the MC4000 instrument
Current Data Table	Same as selecting *Current Data Table* on the MC4000 instrument
Peak pressure P1	Same as selecting *Peak Pressure P1* on the MC4000 instrument

Info

About	Version number and contact information

Language

Change	English / Default (local language, such as Spanish)
Install new	Installs new language file into the MC4000

Menu Tabs

The menu tabs immediately below the main drop downs duplicates the most frequently used item from the *Select* menu.

Measurement	Same as selecting *Measurement* on the MC4000 instrument
Menu MC4000	Same as pressing **MENU** on the MC4000 instrument
Datalogger	Same as selecting *Datalogger* on the MC4000 instrument

Measurement Tab

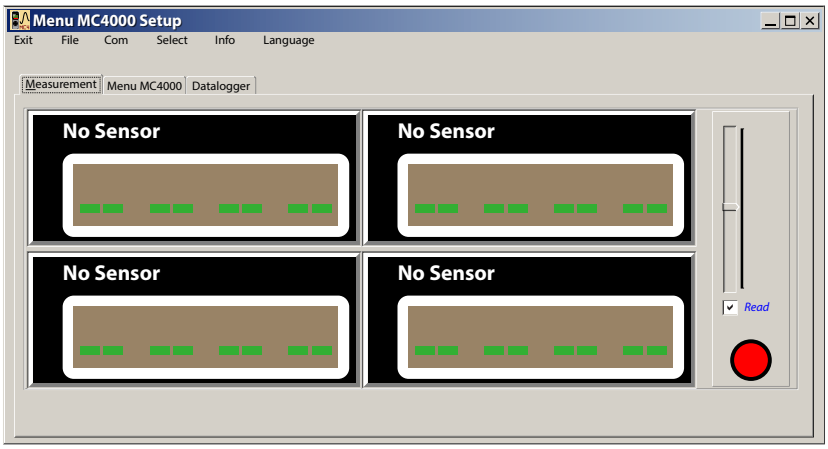


Figure 11: MC4000 Setup Menu

Read	Clicking the *Read* check box in the measurement screen transfers stored data to the PC from the MC4000.
Contrast	The display contrast is set using the slider bar to the right of the sensor displays.

MC4000 Setup Tab

Under the *Menu MC4000* tab, all instrument parameters can be set and then uploaded to the MC4000. The MC4000 also transfers the process parameters and saved data currently displayed on this screen to the PC.

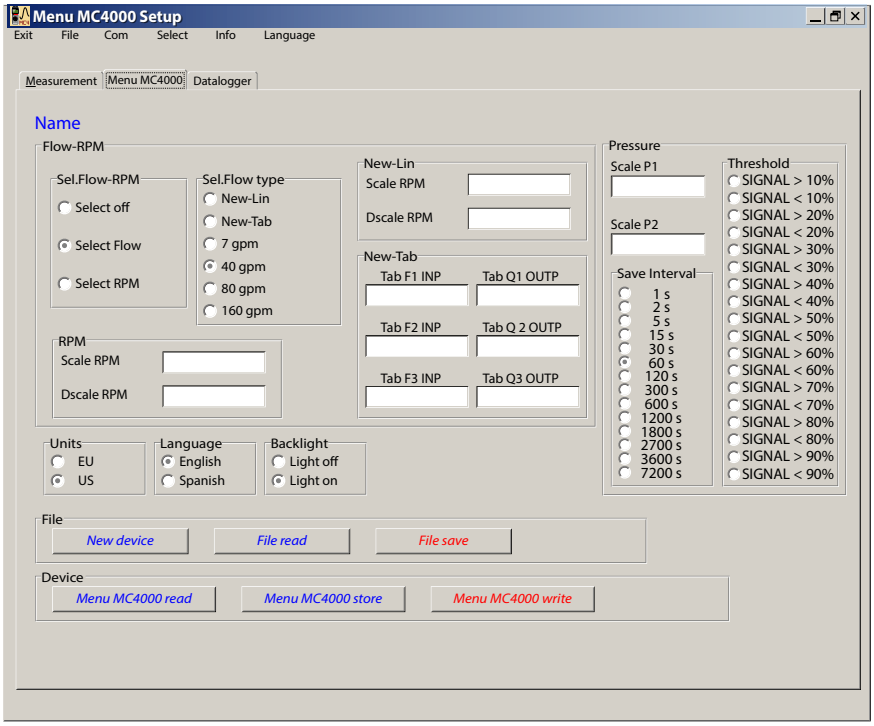


Figure 12: Main MC4000 setup screen

Sel. Flow-RPM	**Select flow and rpm settings.**
Select off	Flow measurement display deactivated (display shows ----)
Select Flow	Flow measurement is active
Select RPM	RPM measurement is active

Sel. Flow type	**Select the flow rate for the currently connected flow sensor.**
7 gpm (25 lpm)	Default parameters for 7 gpm (25 lpm) flow sensor
40 gpm (150 lpm)	Default parameters for 40 gpm (155 lpm) flow sensor
80 gpm (300 lpm)	Default parameters for 80 gpm (300 lpm) flow sensor
160 gpm (600 lpm)	Default parameters for 160 gpm (600 lpm) flow sensor

New-Lin	**Two point calibration for linear flow meter.**	
Scale Flow	Scale the multiplication constant.	See *"Two Point Flow Sensor Calibration Using the New Lin Function" on page 14.*
Dscale Flow	Scale the division constant.	

Pressure	**Pressure parameter settings**
Scale P1	Full scale for the first pressure sensor (P1)
Scale P2	Full scale for the optional pressure sensor (P2)
Save Interval	Sampling and recording rate during data collection.
Threshold	The threshold signal level for the P1 (Transient). Defines the point at which transient recording starts

RPM	**RPM parameter settings**
Scale rpm	Multiplication constant for rpm scaling
Dscale rpm	Division constant for rpm scaling

New-Tab	**Three point linearizing of flow sensors**				
Example					
Tab F1 INP	First frequency point	0 Hz	Tab Q1 OUT	First displayed flow reading	0 LPM
Tab F2 INP	Second frequency point	166 Hz	Tab Q2 OUT	Second displayed flow reading	38 LPM
Tab F3 INP	Third frequency point	630 Hz	Tab Q3 OUT	Third displayed flow reading.	150 LPM

Units	**Flow units are calculated in US or European standard units**
EU	Default units are lpm, bar, ° C
US	Default units are gpm, psi, ° F

Language	**Selection of English or default (the local country language)**
English	
Default	

Backlight	**Backlight control**
Light off	Backlight is turned off, no instrument backlight
Light on	Backlight is turned on the display and illuminates for 30 seconds when any buttons are pressed

File	**Menu MC4000, upper tree switches**
New Device	Default setting
File Read	Reads all the menu parameters from a file with the file format *filename.set* from the MC4000
File Save	Stores all the menu parameters in a file with the format *filename.set* to the MC4000

Device	**Menu MC4000, lower three switches**
Menu MC4000 read	Reads the stored MC4000 parameters into the MC4CON software
Menu MC4000 store	Reads the stored MC4CON parameters into the MC4000
Timer MC4000 write	Transfer time and date values from the PC into MC4000

Datalogger Tab

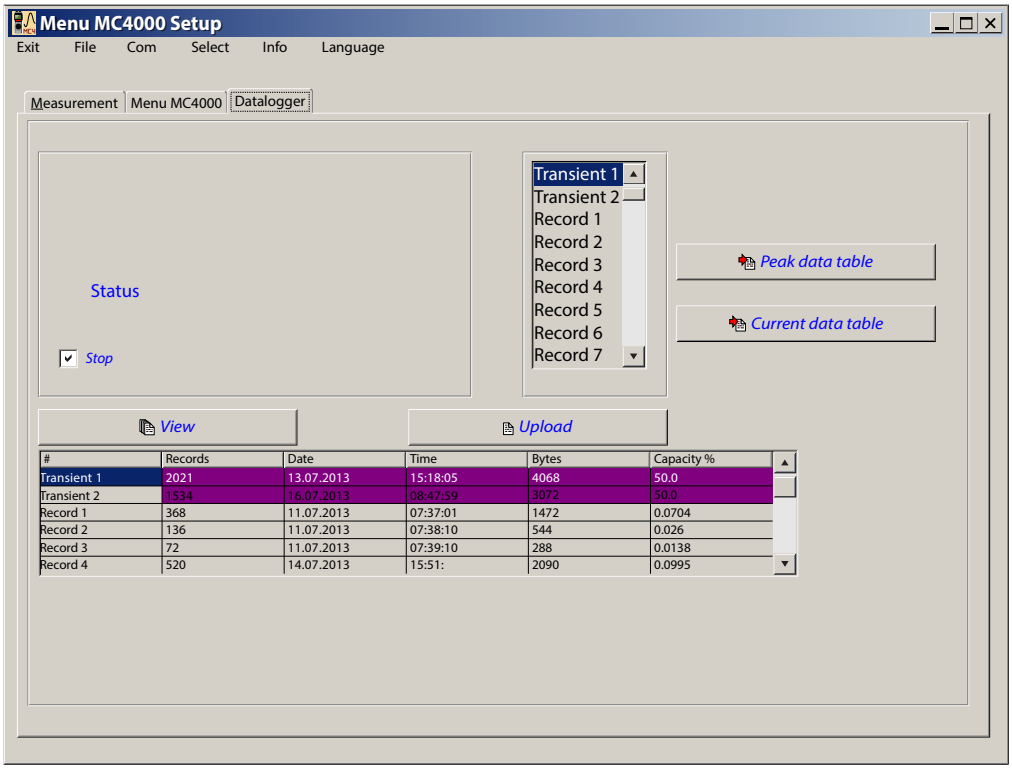


Figure 13: Datalogger view screen

The datalogger screens allow access to all recorded files shown with date, time and controls for instrument data storage. There are also controls to show tabular views of current and peak pressure measurements.

Stop	Stops the software screen updating during the data transfer from the MC4000 to the PC
Peak Data Table	Transients data shown in table format
Current Data Table	Datalogger data shown in table format
View	Show all stored transients and records with date, time and byte content
Upload	Read the selected record (Transient 1, 2, Record 1…)

Data Table Controls

The peak pressure and current data tables use the same controls for manipulating the available data.

Save TXT	Stores the table in a *.txt	
Excel Open	Stores the table in Microsoft Excel *.xls format	
Copy	Copies the current file	
Delete	Deletes the current file	
Open TXT	Opens a previously stored file	
Graph	Generates a graphics representation of the current table	
Cancel	Exits from the current data table	
Print	Prints the current table. The graphic view prints after the table is converted into graphic	
Format	US	Uses a decimal point as number separator
	EU	Uses a comma as number separator

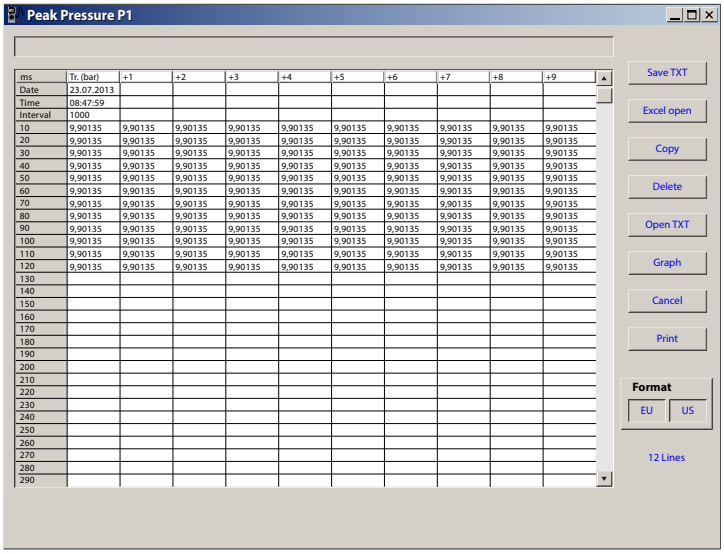


Figure 14: Peak pressure table

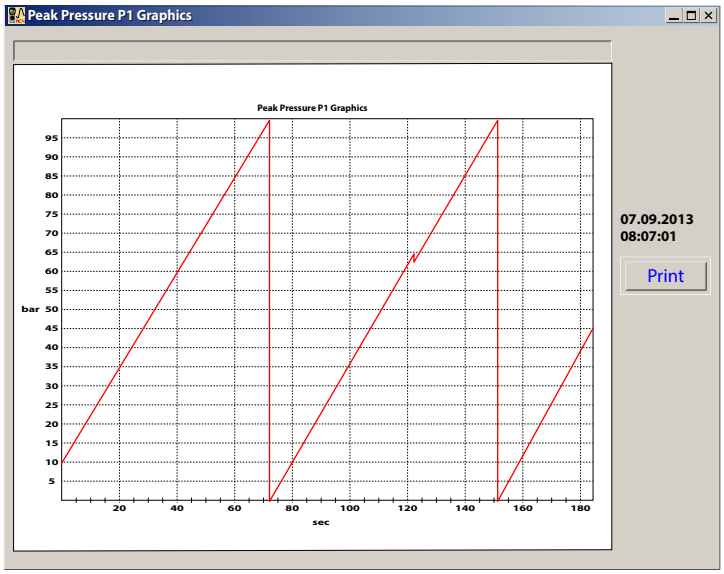
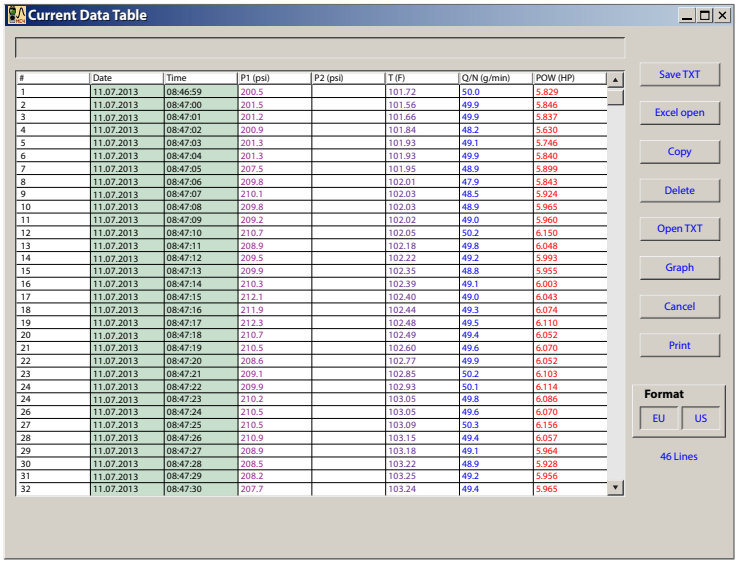


Figure 15: Peak pressure graphics screen

Current Data Table

The current data table shows all four signal channels plus the calculated power.



#	Date	Time	P1 (psi)	P2 (psi)	T (F)	Q/N (g/min)	POW (HP)
1	11.07.2013	08:46:59	200.5		101.72	50.0	5.829
2	11.07.2013	08:47:00	201.5		101.56	49.9	5.846
3	11.07.2013	08:47:01	201.2		101.66	49.9	5.837
4	11.07.2013	08:47:02	200.9		101.84	48.2	5.630
5	11.07.2013	08:47:03	201.3		101.93	49.1	5.746
6	11.07.2013	08:47:04	201.3		101.93	49.9	5.840
7	11.07.2013	08:47:05	207.5		101.95	48.9	5.899
8	11.07.2013	08:47:06	209.8		102.01	47.9	5.843
9	11.07.2013	08:47:07	210.1		102.03	48.5	5.924
10	11.07.2013	08:47:08	209.8		102.03	48.9	5.965
11	11.07.2013	08:47:09	209.2		102.02	49.0	5.960
12	11.07.2013	08:47:10	210.7		102.05	50.2	6.150
13	11.07.2013	08:47:11	208.9		102.18	49.8	6.048
14	11.07.2013	08:47:12	209.5		102.22	49.2	5.993
15	11.07.2013	08:47:13	209.9		102.35	48.8	5.955
16	11.07.2013	08:47:14	210.3		102.39	49.1	6.003
17	11.07.2013	08:47:15	212.1		102.40	49.0	6.043
18	11.07.2013	08:47:16	211.9		102.44	49.3	6.074
19	11.07.2013	08:47:17	212.3		102.48	49.5	6.110
20	11.07.2013	08:47:18	210.7		102.49	49.4	6.052
21	11.07.2013	08:47:19	210.5		102.60	49.6	6.070
22	11.07.2013	08:47:20	208.6		102.77	49.9	6.052
23	11.07.2013	08:47:21	209.1		102.85	50.2	6.103
24	11.07.2013	08:47:22	209.9		102.93	50.1	6.114
24	11.07.2013	08:47:23	210.2		103.05	49.8	6.086
26	11.07.2013	08:47:24	210.5		103.05	49.6	6.070
27	11.07.2013	08:47:25	210.5		103.09	50.3	6.156
28	11.07.2013	08:47:26	210.9		103.15	49.4	6.057
29	11.07.2013	08:47:27	208.9		103.18	49.1	5.964
30	11.07.2013	08:47:28	208.5		103.22	48.9	5.928
31	11.07.2013	08:47:29	208.2		103.25	49.2	5.956
32	11.07.2013	08:47:30	207.7		103.24	49.4	5.965

Figure 16: Current data table

sCurrent Data Graphics

Automatically generates and loads graphics from the *Current Data Table* to the display by clicking on **Graph**.

Graph

This function generates graphics from the *Current Data Table*. All five of the variables are displayed simultaneously. The right side of the window shows the scaled values of the measured signals. The maximum and minimum values are the default. If required, individual variables may be deselected.

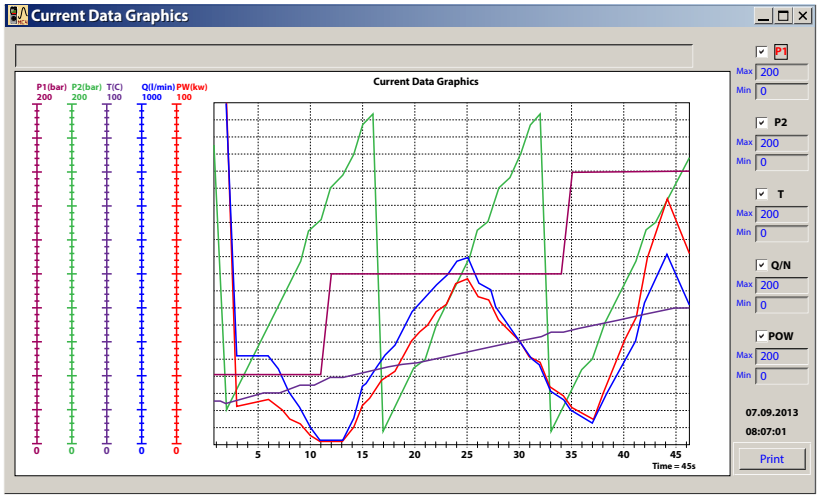


Figure 17: Graph of current data

Defaults

Variable	Minimum	Maximum
P1	0	200
P2	0	200
T	0	100
Q/N	0	1000
POW	0	100

TROUBLESHOOTING GUIDE

Symptom	Possible Cause	Remedy
Meter indicates higher than actual flow rate.	• Cavitation • Debris on rotor support • Build up of foreign materials in the meter bore • Gas in liquid	• Increase back pressure • Clean meter • Clean meter • Install gas eliminator ahead of meter
Meter indicates lower than actual flow rate.	• Debris on rotor • Worn bearing • Viscosity higher than calibrated	• Clean meter and add filter • Clean meter and add filter • Recalibrate monitor
Erratic system indication, meter alone works well (remote monitor application only).	Ground loop in shielding	Ground shield one place only. Look for internal electronic instrument ground. Reroute cables away from electrical noise.
Indicator shows flow when shut off.	Mechanical vibration causes rotor to oscillate without turning.	Isolate meter.
No flow indication. Full or partial open position.	Fluid shock, full flow into dry meter or impact caused bearing separation or broken rotor shaft.	Rebuild meter with repair kit and recalibrate monitor. Move to location where meter is full on start-up or add downstream flow control valve.
Erratic indication at low flow, good indication at high flow.	Rotor has foreign material wrapped around it.	Clean meter and add filter.
No flow indication.	Faulty pickup.	Replace pickup.
System works perfect, except indicates lower flow over entire range.	By-pass flow, leak.	Repair or replace by-pass valves, or faulty solenoid valves.
Meter indicating high flow, upstream piping at meter smaller than meter bore.	Fluid jet impingement on rotor.	Change piping.
Opposite effects of above.	Viscosity lower than calibrated.	Change temperature, change fluid or recalibrate meter.
Meter doesn't respond to any changes in process inputs or keystrokes.	Processor hang due to communications interruption.	Perform a hardware reset by inserting the end of a paperclip into the hardware reset hole on the left side of the enclosure. See *Figure 3 on page 6*. **NOTE:** For this procedure to work, the charger must be disconnected from the MC4000.

SPECIFICATIONS

Display		
Accuracy	±0.1% + 1 digit from midrange	
A to D	16-bit, Linearity ± (1 LSB + 1 digit)	
Display	Graphic LCD display with back light, 128 x 64 pixels; back light auto-off function	
Inputs	Flow Pressure (P1/P2) Temperature (T) RPM	10 mV…5V $_{P-P}$ sine wave from turbine; frequency range 0.5…10 kHz scalable Dual 4…20 mA Pt-100 –50…500° C 5…24V active pickup; range 30…60,000 rpm
Keypad	Nine keys on the front; backlight is illuminated for 30 seconds after any key is pressed	
Power	Battery Charger	6V, 2 Ah 100…240V AC
	A fully charged battery permits about four hours of operation with two pressure sensors connected and the backlight switched off	
Memory	2.5 MB of datalogging memory can store up to 80,000 samples in all four signal channels, calculated power, date and time; the sampling rate is selectable from 1 sec…120 min	
	Peak & valley functions stores the maximum and the minimum values of the P1 and P2 pressure sensors	
	Two fast transients recorders with a sampling rate of 1 ms and a capacity of 240,000 measurements monitor pressure sensor P1. The recording trigger threshold is programmable between 0…100%	
Tare	Pressure channels P1 and P2 are independently set to zero	
Connections	Two eight-pin, 12 mm sensor plugs, USB data connection, battery charging connection	
Indicators	Green LED between the two sensor plugs indicates power to the battery charging circuit	
Environmental	Ambient Temperature Humidity	–22…158° F (–30…70° C) 0…90% non-condensing.
Sensors		
Accuracy	± 1% of reading @ 32 cSt	
Repeatability	± 0.2%	
Pressure max	5800 psi (400 bar) max; 5000 psi (345 bar) max for SAE 20 and G 1-1/4 size models	
Turbine response time	≤200 ms	
Environmental	Fluid Temperature Ambient Temperature Humidity	–4…300° F (–20…150° C) –22…158° F (–30…70° C) 0…90% non-condensing
Materials		
Turbine	Housing	6013-T651 anodized aluminum
	Turbine rotor	T416 stainless steel
	Rotor supports	6061-T6 aluminum alloy
	Rotor shaft	T303 stainless steel
	Ball bearings	440 C stainless steel
	Hub cones	6061-T6 aluminum alloy
	Retaining rings	6061-T6 aluminum allow
	Adapters/plugs	6061-T6 anodized aluminum
	Seals	Buna N
Pickup	Housing	6016-T6 nickel plated
	Nut	T303 stainless steel
	Connector	Brass
Pressure Sensor	Case	300 Series stainless steel
	Diaphragm	17-4 PH stainless steel

DIMENSIONS

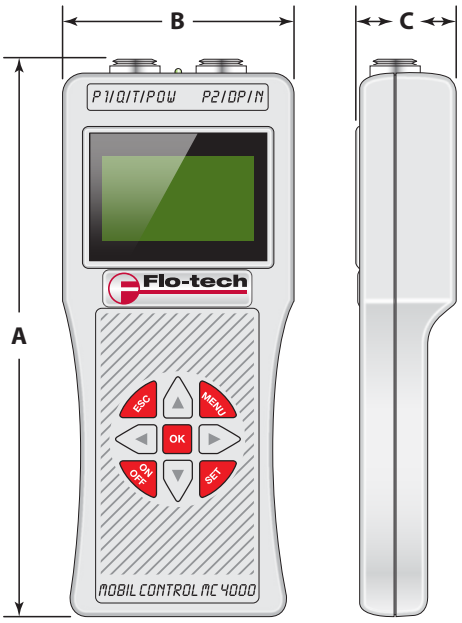


Figure 18: MC4000 monitor

A	B	C
8.70 in. (221 mm)	3.62 in. (92 mm)	1.62 in. (41 mm)

Table 2: Monitor dimensions

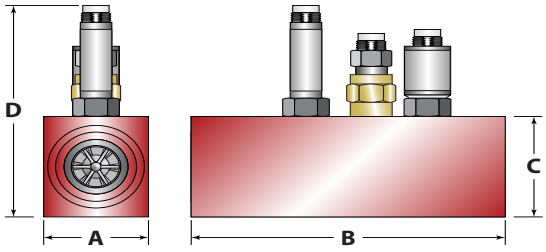


Figure 19: MC4000 sensor arrays

SERIES	A	B	C	D
SAE 8 (G 1/4)	1.23 in. (31.2 mm)	4.72 in. (120.0 mm)	1.47 in. (37.3 mm)	3.91 in. (99.3 mm)
SAE 12 (G 3/4)	1.50 in. (37.6 mm)	5.08 in. (129.0 mm)	1.80 in. (45.7 mm)	4.24 in. (107.7 mm)
SAE 16 (G 1)	1.96 in. (50.3 mm)	5.87 in. (149.0 mm)	2.20 in. (56.0 mm)	4.64 in. (117.9 mm)
SAE 20 (G 1–1/4)	2.46 in. (62.5 mm)	6.81 in. (173.0 mm)	2.48 in. (63.0 mm)	4.92 in. (125.0 mm)

Table 3: Sensor array dimensions

MODEL NUMBERS

MC4000 Handheld System Analyzer [ ] – [ ][ ][ ][ ][ ]

Model							
MC4000 Handheld System Analyzer	**FMC4**						
Language							
English + Spanish		**1**					
English + French		**2**					
English + German		**3**					
English + Italian		**4**					
Power Cord							
International			**2**				
North American			**3**				
Flow Sensor							
0.4…7 gpm (1.5…26 lpm) SAE 8				**1**			
1…40 gpm (4…151 lpm) SAE 12				**2**			
4…80 gpm (15…302 lpm) SAE 16				**3**			
8…160 gpm (30…605 lpm) SAE 20				**4**			
0.4…7 gpm (1.5…26 lpm) G 1/4				**5**			
1…40 gpm (4…151 lpm) G 3/4				**6**			
4…80 gpm (15…302 lpm) G 1				**7**			
8…160 gpm (30…605 lpm) G 1–1/4				**8**			
Pressure Sensor							
None					**N**		
870 psi (60 bar)					**1**		
1450 psi (100 bar)					**2**		
3625 psi (250 bar)					**3**		
5800 psi (400 bar)					**4**		
Temperature Sensor							
None							**N**
392° F (200° C)							**1**

Control. Manage. Optimize.

www.badgermeter.com

The Americas | Badger Meter | 4545 West Brown Deer Rd | PO Box 245036 | Milwaukee, WI 53224-9536 | 800-876-3837 | 414-355-0400
México | Badger Meter de las Americas, S.A. de C.V. | Pedro Luis Ogazón N°32 | Esq. Angelina N°24 | Colonia Guadalupe Inn | CP 01050 | México, DF | México | +52-55-5662-0882
Europe, Middle East and Africa | Badger Meter Europa GmbH | Nurtinger Str 76 | 72639 Neuffen | Germany | +49-7025-9208-0
Europe, Middle East Branch Office | Badger Meter Europe | PO Box 341442 | Dubai Silicon Oasis, Head Quarter Building, Wing C, Office #C209 | Dubai / UAE | +971-4-371 2503
Czech Republic | Badger Meter Czech Republic s.r.o. | Mařikova 2082/26 | 621 00 Brno, Czech Republic | +420-5-41420411
Slovakia | Badger Meter Slovakia s.r.o. | Racianska 109/B | 831 02 Bratislava, Slovakia | +421-2-44 63 83 01
Asia Pacific | Badger Meter | 80 Marine Parade Rd | 21-06 Parkway Parade | Singapore 449269 | +65-63464836
China | Badger Meter | 7-1202 | 99 Hangzhong Road | Minhang District | Shanghai | China 201101 | +86-21-5763 5412

Legacy Document Number: MC4000_GB_2910